REMARKS AND ARGUMENTS

Pending claims 1-31 were examined and rejected. At ¶5 of the Office Action, claims 1-31 were rejected under 35 USC §103(a) as being unpatentable over US patent 6,422,598 to Yasui (Yasui '598) in view of US patent 6,302,438 to Stopper (Stopper '438)..

Applicants have amended independent claims 1 and 15 to further distinguish over the art of record, and have amended claim 3. Claims 1-31 remain pending.

1. AMENDED CLAIM 1 AND AMENDED CLAIM 15 ARE SUPPORTED BY THE SPECIFICATION

Applicants have amended claim 1 to recite that the present invention acquires data from:

> a sensor system that emits optical energy toward a scene and includes an array of detection pixels in which each pixel captures three-dimensional depth information of a corresponding location of said scene using a reflected fraction of said emitted optical energy, each said pixel further capturing intensity of said reflected fraction of said emitted optical energy as well as capturing intensity of ambient optical energy.

Claim 15 is similarly amended, using system rather than method language.

Support for the amended language to claim 1 and claim 15 may be found in the Specification, e.g., at paras. 0036, 0038, and 0059.

As noted at para. 0038, within "a few milliseconds" after a crash involving a vehicle carrying the present invention, the present invention must complete its determination as to what level (if any) to deploy the vehicle airbag. If the image data acquired is ambiguous, a wrong deployment decision may be reached. Understandably time is of the essence and a deployment decision must be rapidly reached if the airbag is to be deployed in time to do its job. In short, because a complete three-dimensional image of the object is acquired, the

presently claimed invention is enabled to make a timely, intelligent decision as to airbag deployment level.

The presently claimed invention can, within milliseconds following a crash, reach a proper decision as to airbag deployment level because true three-dimensional imagery in acquired in a manner that precludes any ambiguity. As noted in the Specification at para. 0059, there is a one-to-one relationship between individual pixels in applicants' sensor array and individual corresponding locations in the scene. Simply stated, three-dimensional image data is rapidly acquired by the present invention without any ambiguity. As such, rapid and robust determinations as to airbag deployment may be made with high confidence within the few millisecond allowed.

2. AMENDED CLAIM 3 IS SUPPORTED BY THE SPECIFICATION

Amended claim 3(d) recites that determination of airbag deployment level can be based upon one or both of occupancy data most recently captured before a triggering event, or occupancy data captured immediately after occurrence the triggering event. control deployment of said airbag. Both data are available to the system, which "repeatedly capture(s) a plurality of frames of TOF three-dimensional depth images of the scene (see claim 1).

3. AMENDED CLAIMS 1 AND 15 ARE PATENTABLE OVER THE ART OF RECORD, AS ARE ALL CLAIMS DEPENDENT THEREFROM

As noted above, for an airbag deployment system to be worthwhile, it should function rapidly and without having to cope with ambiguous data in determining what level of deployment is called for.

(A) YASUI '598

At para. 5 of the pending Office Action, the Examiner cites Yasui '598 as disclosing determination of deployment level of an airbag by repeatedly capturing frames of "three dimensional depth images" of a scene. However whereas the presently claimed invention acquires true three-dimensional image data, Yasui '598 uses a "two-dimensional image sensor 16" (see col. 4, line 33) in conjunction with an emitted "sheet-like" fan beam of optical energy (see col. 4, line 43-44). The resultant data will be slices of the image taken in the region of intersection with the sheet-like fan beam of emitted optical energy. At col. 5, line 38-40, Yasui asserts that it is "possible to judge whether the occupant is an adult or child from the width of the side face".

However as shown below in Fig. A and Fig. B, this statement is rather optimistic. In Fig. A, Yasui's two-dimensional image data is shown imaging an adult-sized head, with the slice acquired near the neck region, e.g., perhaps the adult is especially tall. In this example, Yasui's system knows only that an object with transverse dimension D has been illuminated with the fan beam. In Fig. B, a child-sized head is imaged with a Yasui system, and returns the same dimension D. Thus in Fig. A and Fig. B to know whether an adult or a child is being imaged, Yasui must acquire more slices and then interpolate data between adjacent slices.

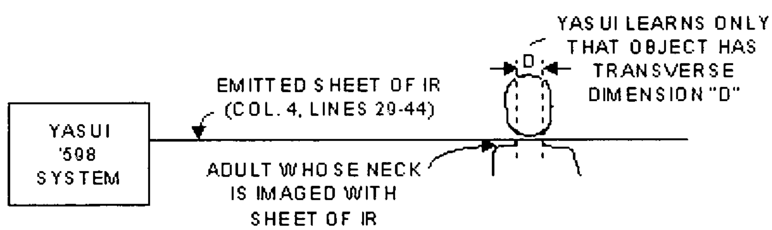

FIG. A

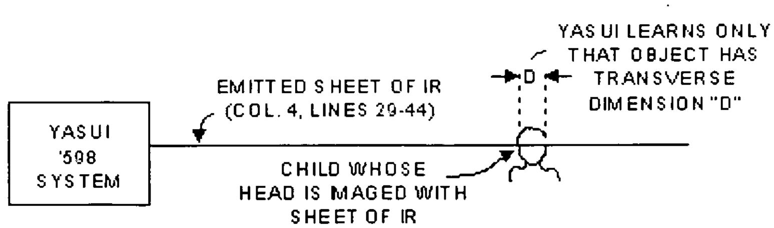

FIG. B

In Yasui's second embodiment, a "plurality" of sheets of light is emitted, to acquire many slices of image data, presumably in the same time period. The resultant data is used by Yasui "to estimate physique of the occupant more reliable"; see col. 6, lines 330-31.

But even if Yasui could generate multiple sheets of light and acquire and process sufficient data within a "few milliseconds" following a vehicle crash, Yasui's simultaneously acquired images will be ambiguous, as shown below in Fig. C.

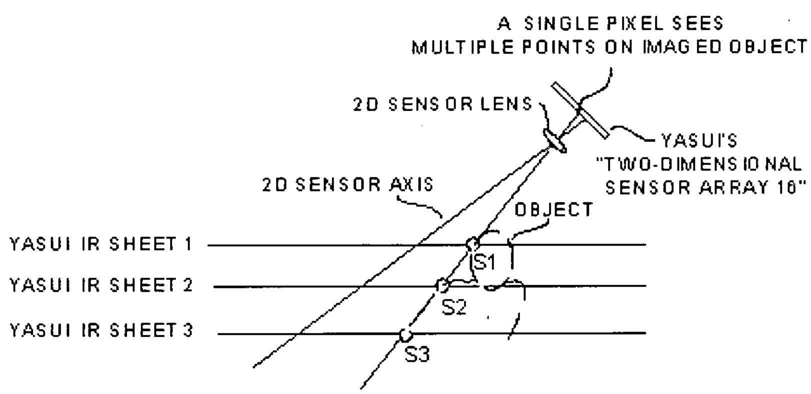

FIG. C

Referring to Fig. C, above in a Yasui system multiple points S1, S2, S3 on the imaged object will all map to the same pixel(s) in Yasui's "two-dimensional sensor 16", thus creating data ambiguity. This assumes that S1 does not occlude S2 and S3. Simply stated, a pixel in Yasui's two-dimensional sensor 16 cannot discern whether the pixel-detected image comes from S1, from S2, or from S3. This data ambiguity is intolerable because Yasui relies upon the location of the reflected beam spot on his two-dimensional sensor to ascertain the actual location of the points on the imaged object (see col. 5, lines 7-20). Thus, there is an ambiguity and as a result Yasui's camera cannot correctly determine the three-dimensional locations of an object or occupant intersecting with multiple sheets of emitted IR optical energy.

The above-noted ambiguity and undesired results in Yasui does not occur with the presently claimed invention, in which the three points S1, S2, S3 will produce three different depth values. Because the presently claimed invention will acquire three different depth values, applicants' sensor system knows whether it is imaging S1, or S2, or S3. Because of the one-to-one relationship between pixels and points on the imaged object in the present invention, there is no ambiguity.

Yasui's third embodiment employs the same image sensor 16 described at col. 4, line 33 as "two-dimensional image sensor 16" and cannot provide true three-dimensional data such as claimed for the present invention.

To recapitulate, the role of an occupant sensing system is not only to determine the location of the occupant but also to classify the type of the occupant, e.g., adult, child, person sitting too close to the airbag, etc. In Yasui, the task of locating and classifying the occupant is dependent upon information gleaned from a narrow slice of the occupant without meaningful information as to the rest of the body of the occupant. To the extend Yasui attempts to provide a multi-slice second embodiment, as shown by Fig. C, his resultant data is ambiguous. Thus applicants respectfully submit that Yasui does not disclose a system that is based upon actual three-dimensional data from an object's (x,y,z) real world coordinates. This is inapposite to the presently claimed invention.

In short, applicants submit that amended claim 1 and similarly amended claim 15 are patentably distinguishable over Yasui' 598, as are all claims dependent from claim 1 or claim 15.

(B) STOPPER '438

As noted, the presently claimed invention uses an array of detection pixels in which each pixel captures three-dimensional depth information of a corresponding location of a scene, using a reflected fraction of emitted optical energy, each said pixel further

capturing intensity of the reflected fraction of emitted optical energy as well as intensity of ambient optical energy. Yasui by his own admission uses a "two-dimensional image sensor", Yasui col. 4, line 33.

At page 4 of the Office Action, Stopper is cited as disclosing a system to measure range information to an occupant using time-of-flight of reflected light. However at a minimum, Stopper's system requires at least two sensor systems. A first sensor system includes a spaced-apart transmitter and receiver to determine distance to the back of the occupant's seat (col. 12, row 29). A second sensor system is required to determine range to the occupant being sensed (col. 12, row 56) in a single dimension.

But none of Stopper's sensor systems is three-dimensional, or indeed is two-dimensional. Stopper determines length as distance between two points. At best, the sensors referenced by Stopper including references to TOF (col. 13, row 17) are distance or proximity sensors. This is evident by Stopper's inclusion of echo-producing acoustic or ultrasound sensors in the same paragraph (col. 13, row 13). None of Stopper's sensors produces three-dimensional data.
Stopper's sensors merely find depth of a part of the target object closest to the sensor using a distance measurement as shown by his Box 112 in Fig 7. At box 112, Stopper makes a decision whether Distance (data obtained from the transmitter/receiver sensor) is greater than Range (i.e., the distance obtained from ranging system). If yes, the sensor bag inflator is enabled. But as noted, Stopper's distances are one dimensional entities and cannot be used to produce three-dimensional data.

Stopper's go/no-go approach to deploying an airbag does not, and indeed cannot, identify the passenger object. If Distance > Range, Stopper deploys the airbag, without regard to whether the object is an adult or a child. Further, it is noted that Stopper's system measures closest distance of an object to the camera-sensor, and not closest distance to the airbag that will be deployed. As a practical matter, if the part of the occupant closest to the sensor is not the occupant part closest to the airbag, Stopper's system cannot make a correct decision about airbag deployment.

In short, Stopper's system uses one-dimensional distance data to determine whether the closest part of an object to his camera sensor exceeds a range value. If yes, then the airbag is deployed, without regard to whether the object is an adult or a child.

Applicants submit that designing a true three-dimensional system to intelligently deploy an airbag is more complicated than attempting to combine portions of a two-dimensional system (Yasui) with portions of a one-dimensional system (Stopper). Indeed, there is no motivation to augment Yasui with Stopper because Stopper may be ranging one part of an object, while Yasui acquires slice information as to another part of the object. The two-dimensional array of Yasui and the one-dimensional sensor data of Stopper do not and cannot satisfy the design goals of intelligently deploying an airbag in a vehicle within milliseconds of impact. By contrast, the array of pixels used in the present invention satisfies the requisite design goals.

Thus, applicants respectfully submit that pending claims 1-31 are patentable over Yasui and/or Stopper, and indeed any other art of record. Applicants refer to but will not repeat their comments made in earlier Office Actions herein with respect to Yasui and Stopper.

CONCLUSION

Applicants submit that the presently amended claims are patentably distinguishable over the art of record, and that claims 1-31 should be passed to allowance at this time. If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided below.

Respectfully submitted,

CANESTA, INC.

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